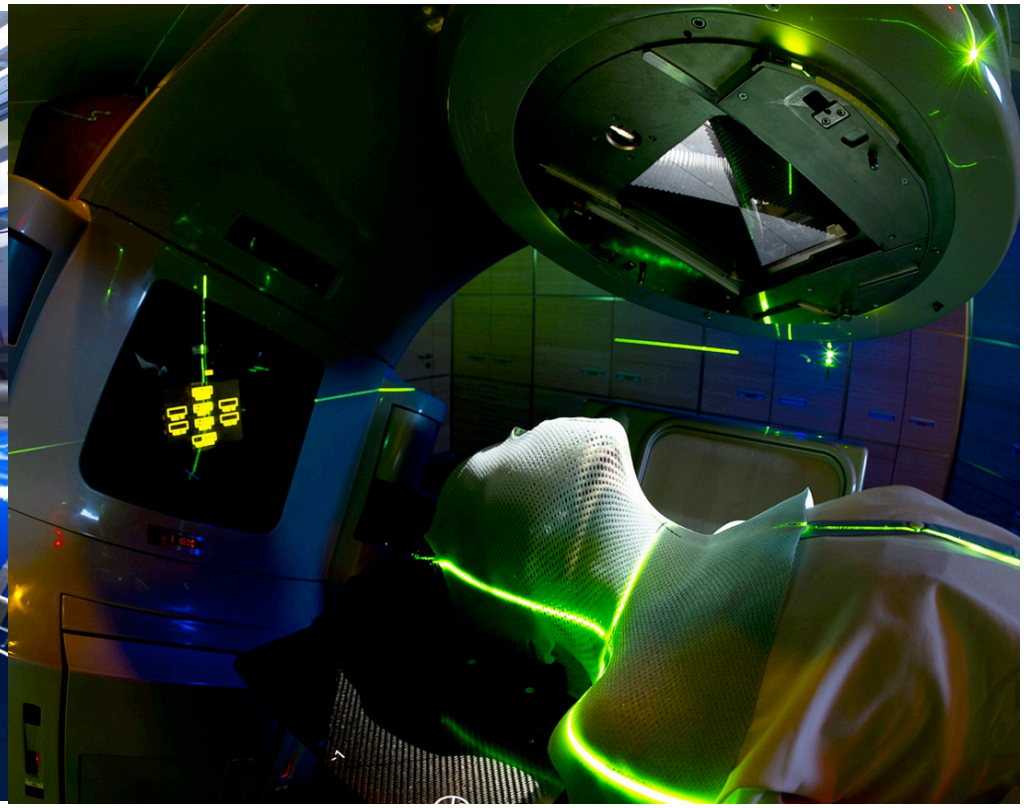
From Physics to Medical Applications



EPS-TIG

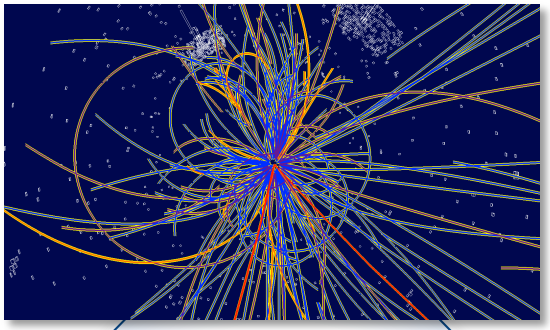
Advanced Radiation Detectors for Industrial Use

Ravenna, 11 November 2013

Manjit Dosanjh, KT, CERN

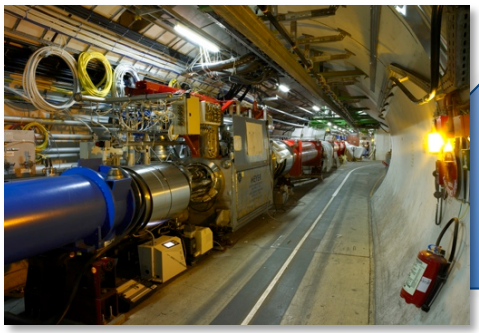
CERN Technologies and innovation

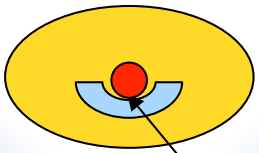
accelerators, detectors and IT to fight cancer



Detecting particles

Accelerating particle beams





CANCER

Large-scale computing (Grid)

Cancer is a large and growing challenge

Need: Earlier diagnosis, better control, fewer side-effects

How?

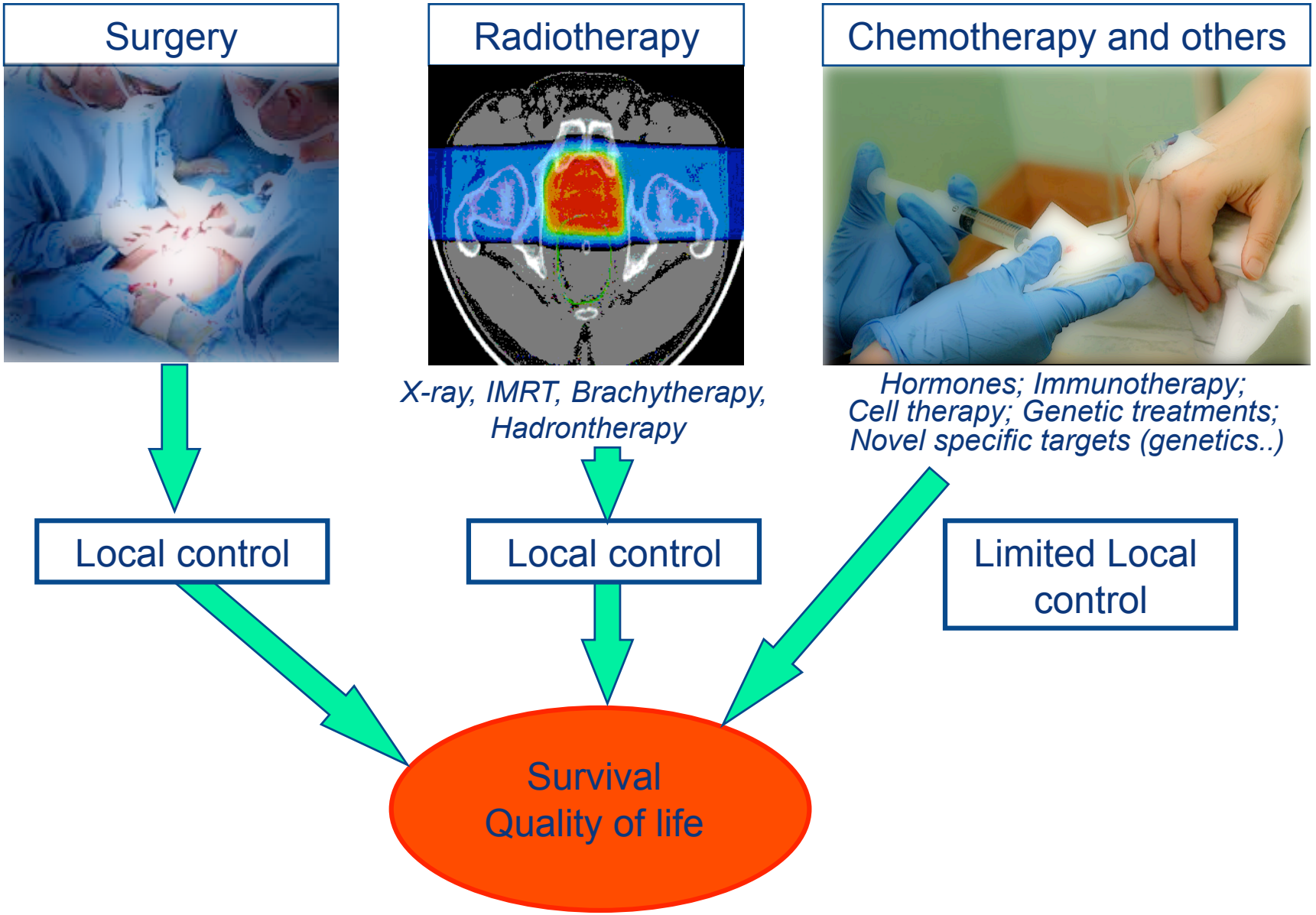
- new technologies
  - Imaging, dosimetry, accelerator & detector technology
  - Better understanding – genetics, radiobiology…
  - Advanced healthcare informatics …
- international collaboration
  - If progress is to be maintained

Although cancer is a common condition, each tumour is individual

→ personalised approach

→ Large patients data to understand the key drivers of the disease

Cancer Treatment Options…



Conventional Radiotherapy in 21st Century

3 "Cs" of Radiation

Cure (~ 45% cancer cases are cured)

Conservative (non-invasive, few side effects)

Cheap (~ 5% of total cost of cancer on radiation)

There is no substitute for RT in the near future

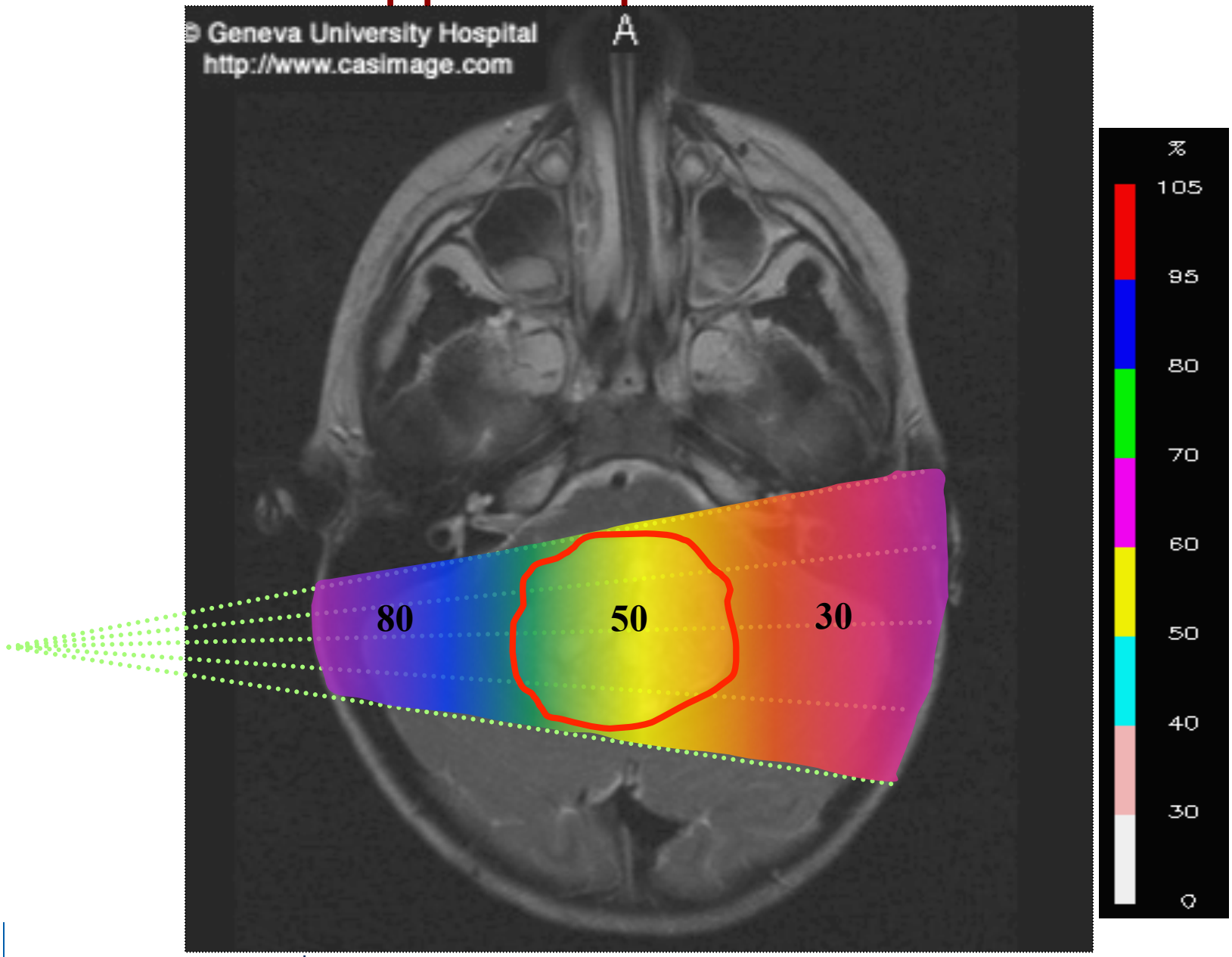
The rate of patients treated with RT is increasing

Present Limitation of RT:

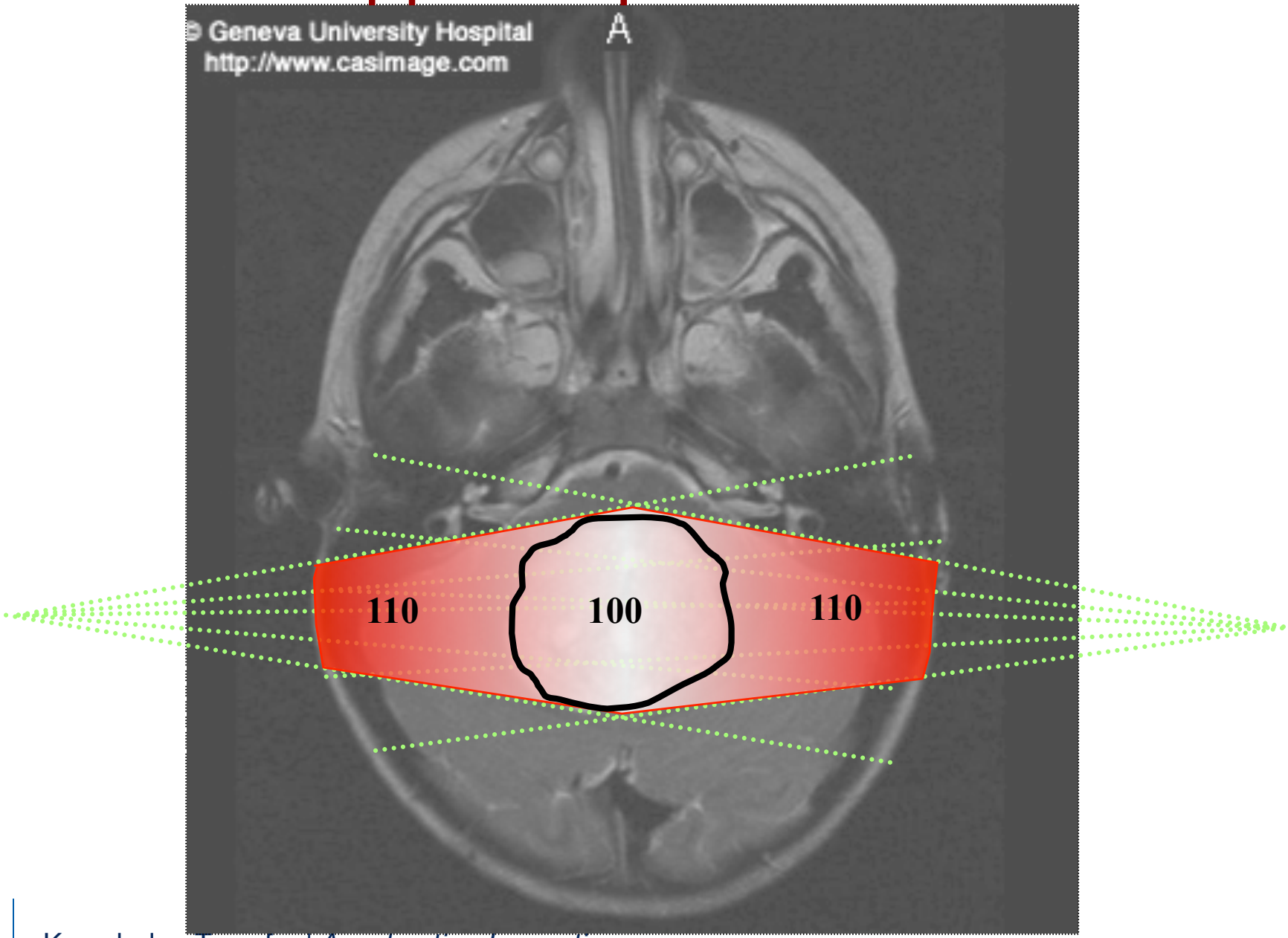
~30% of patients treatment fails locally

J.P.Gérard, ESTRO

Two opposite photon beams



Two opposite photon beams



How to decrease failure rate?

- Accelerator technologies to improve treatment: higher dose
- Detectors/imaging: accuracy, multimodality, real-time, organ motion
- Data: storage, analysis and sharing (confidentiality, access)
- Biology: fractionation, radio-resistance, radio-sensitization
- Collaboration in this multidisciplinary field is key

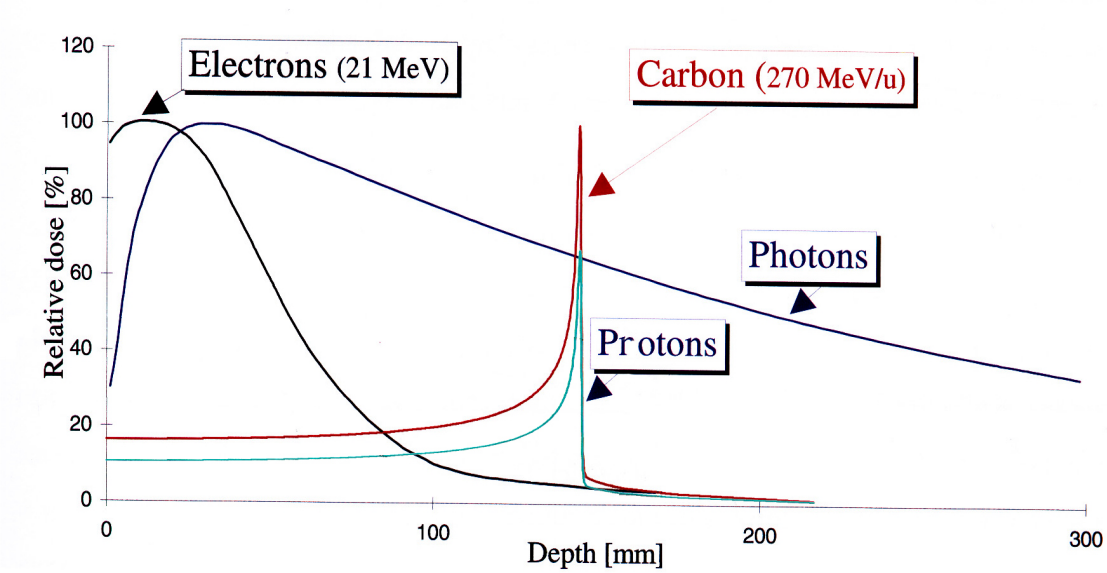
Raymond Miralbell, HUG

Hadrontherapy: all started in 1946

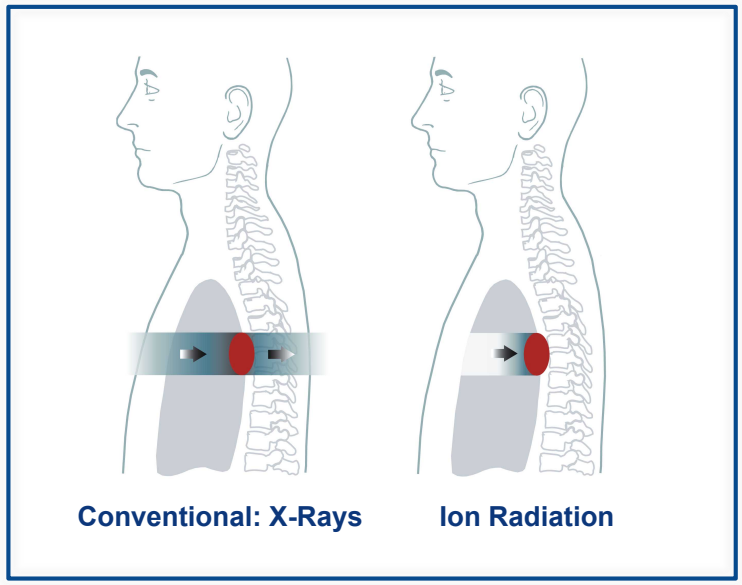
In 1946 Robert Wilson:

- **Protons can be used clinically**
- **Accelerators are available**
- **Maximum radiation dose can be placed into the tumour**
- **Particle therapy provides sparing of normal tissues**

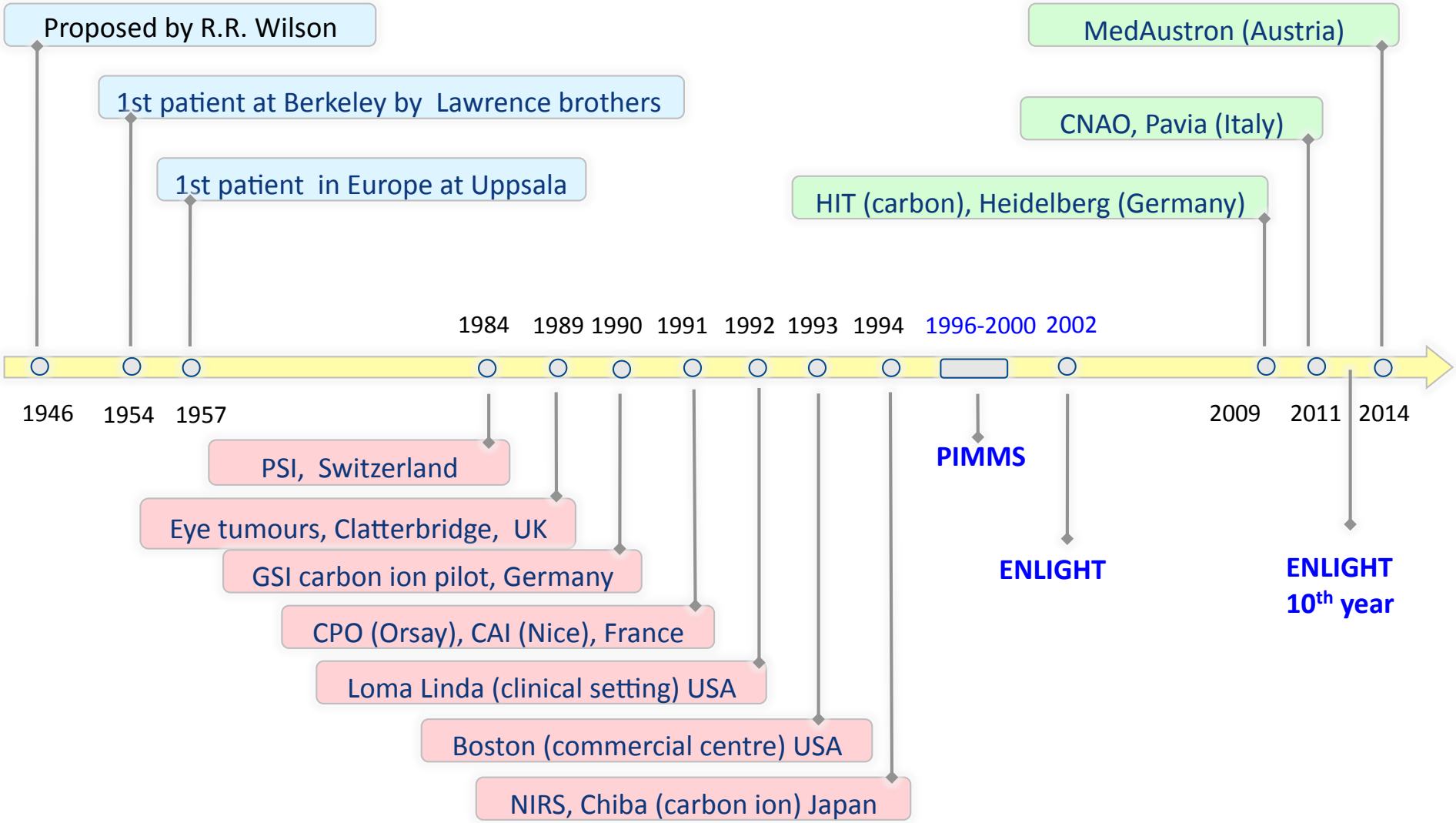
- Tumours near critical organs
- Tumours in children
- Radio-resistant tumours



Depth in the body (mm)

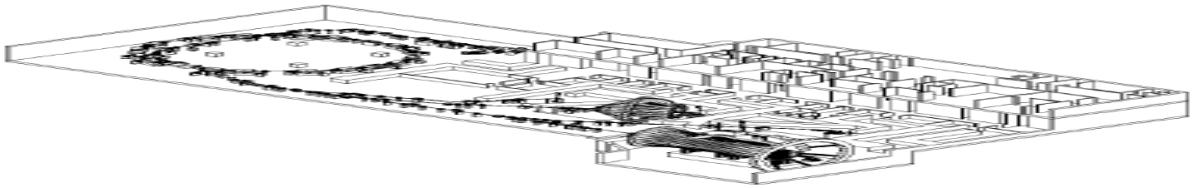


Proton & Ion Beam Therapy: a short history



Accelerator technologies and KT

PIMMS 2000
(coordinated by
CERN) has led to:



TERA
Fondazione per Adroterapia Oncologica

fondazioneCNAO

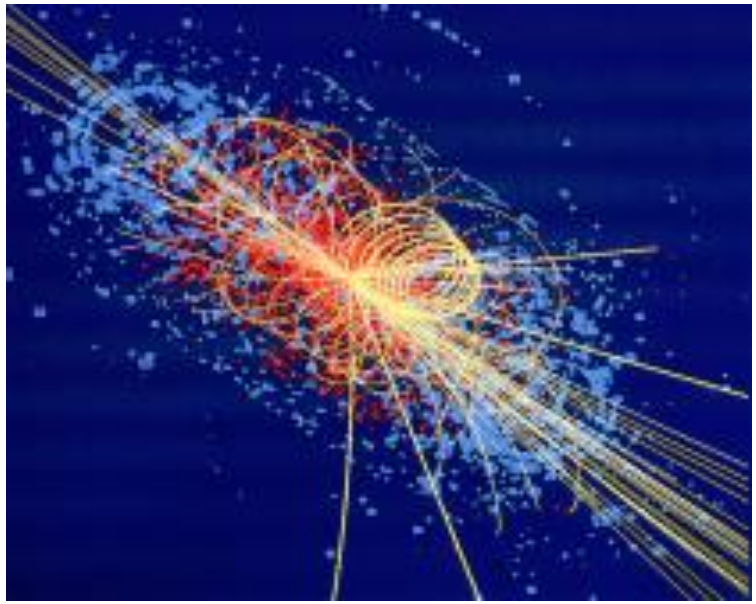
Treatment centre in Pavia, Italy.
First patient treated in Sept 2011

ebg *Med*Austron

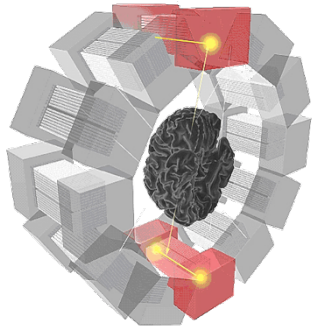
Treatment centre in Wiener Neustadt, Austria,
foundation stone 16 March 2011, will be ready in 2015

No treatment without detection!

Particle Detection

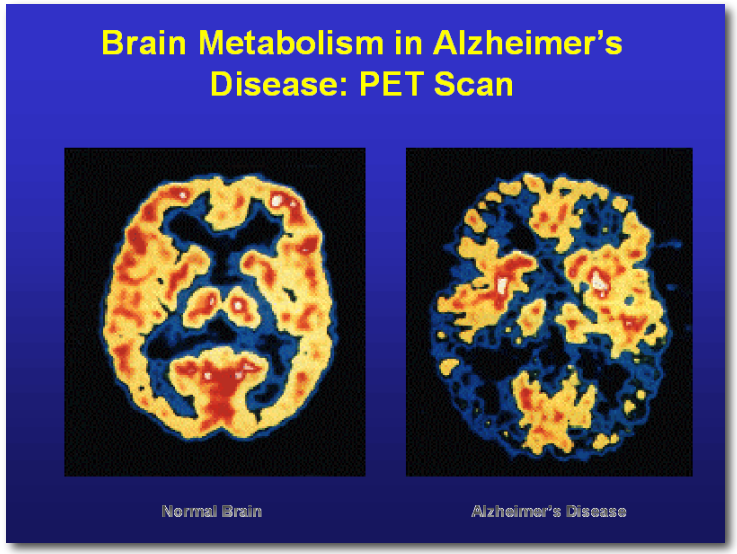


Imaging



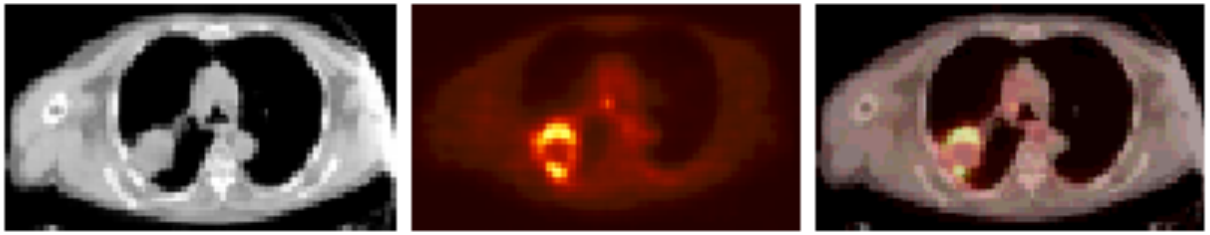
PET Scanner

Breast imaging
(ClearPEM)



Detector Technologies

- Detector technology – improved photon detection and measurement: Crystal Clear, PET, PEM, Axial PET
- Electronics and DAQ – high performance readout: (Medipix)
- Multimodality imaging: PET-CT (proposed by Townsend, future with PET-MRI)
- MEDICIS: new ways of detection and treatment



CT PET PET-CT

@ CERN

The Crystal Clear Collaboration was created in 1990, now :

- Generic R&D on scintillating materials and photo-detectors
- High energy physics related projects on scintillating detectors and related readout electronics
- Applied Research Projects mainly in medical imaging:
  Small animal PET scanner (ClearPET)
  Dedicated PET
    for mammography: ClearPEM/ClearPEM-Sonic
    EndoTOFPET-US
    BrainPET

http://crystalclear.web.cern.ch/crystalclear/

Catalysing collaboration in health field

Challenges:

- Bring together physicists, biologists, medical physicists, doctors
- Cross-cultural at European and global level

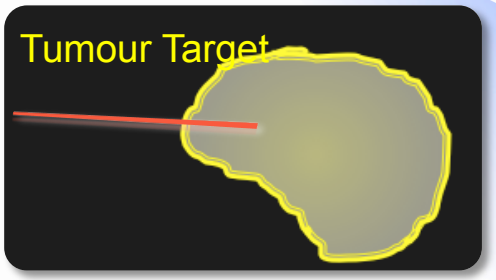
Why is CERN/HEP well placed to do this?

- It is widely acknowledged as a ***provider of technologies*** and as a ***catalyst*** for collaboration.
- It is international, non-commercial, not a health facility.

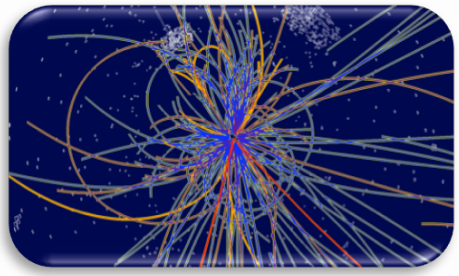
Catalysing & facilitating collaboration

Accelerating particle beams

Particle Therapy



Detecting particles



Medical imaging

Large scale **computing** (Grid)

Grid computing for medical data management and analysis

10 years of ENLIGHT collaboration

- Common mu
- Identify cha
- Share knov
- Share bes
- Harmonis
- Provide t
- Innovate
- Lobbyin

Coordina

> 150 institutes

> 400 people

> 25 countries

(with >80% of MS involved)

EU funded projects

- Wide range of hadron therapy projects: training, R&D, infrastructures
- A total funding of **~24 M Euros**
- All coordinated by CERN,(except ULICE coordinated by CNAO
- Under the umbrella of ENLIGHT

PARTNER

- Marie Curie ITN
- 12 institutions

ULICE

- Infrastructures for hadron therapy
- 20 institutions

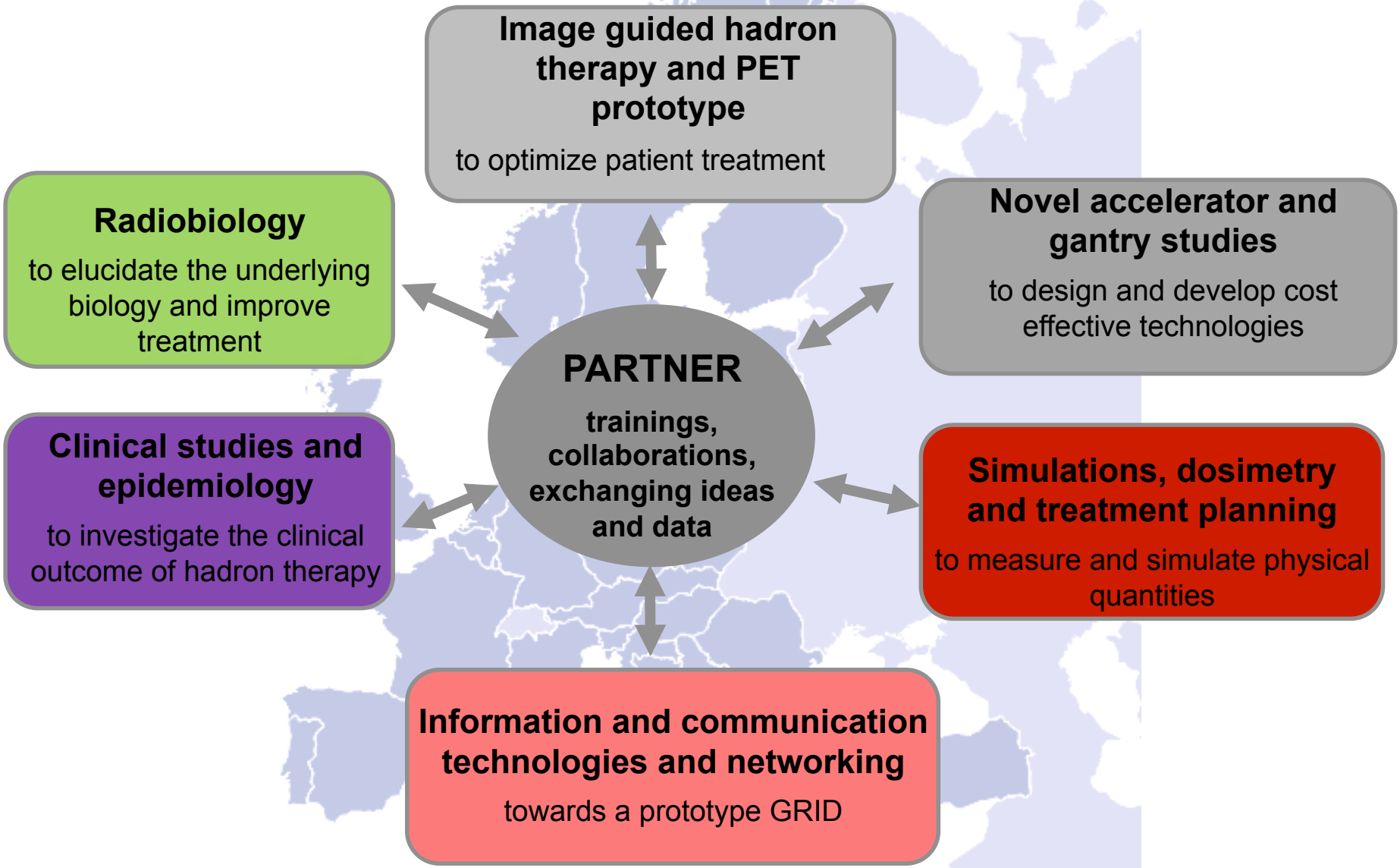
ENVISION

- R&D on medical imaging for hadron therapy
- 16 institutions

ENTERVISION

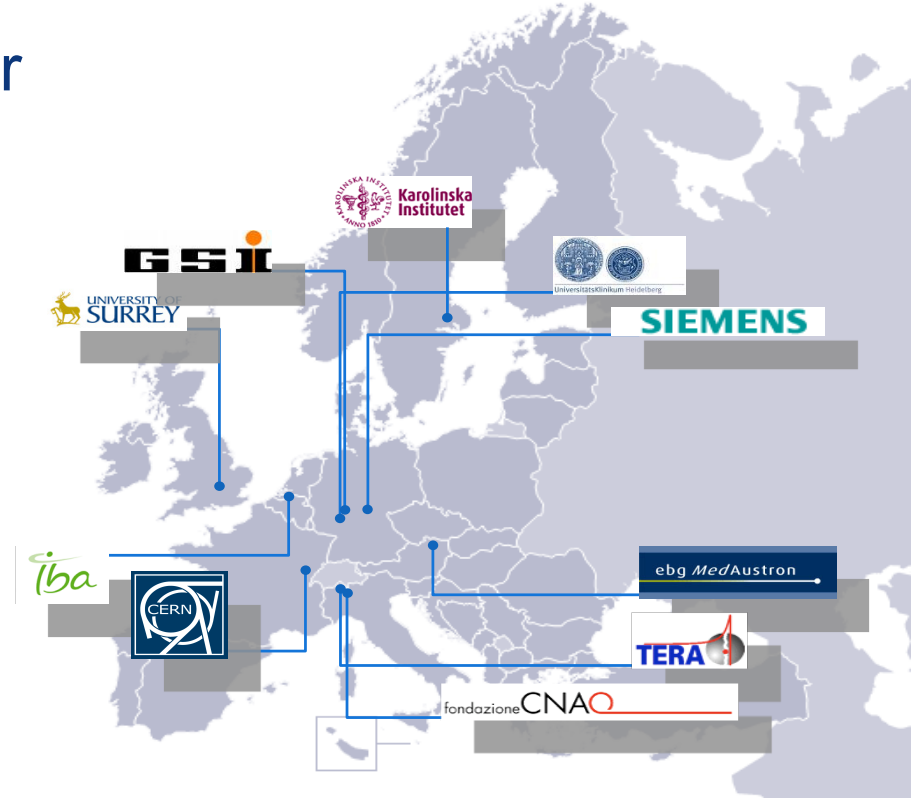
- Marie Curie ITN
- 12 institutions

PARTNER – research areas



PARTNER – a success story

- Particle Training Network for European Hadrontherapy
- 10 academic institutes, research centres, 2 leading companies
- 29 young researchers



Outcome :

- Now working around the World
- Open access PARTNER-JRR

ULICE

- Transnational access to beam time at HIT and CNAO successfully implemented
- Joint research activities: New gantry design being finalized
- Networking

  Training courses at HIT and CNAO
  - For physicians and physicists already working in hadron therapy
  - For physicians, physicists, biologists who want beam time for their experiments

Project extended by a year!

Next meeting – June 2014, CERN

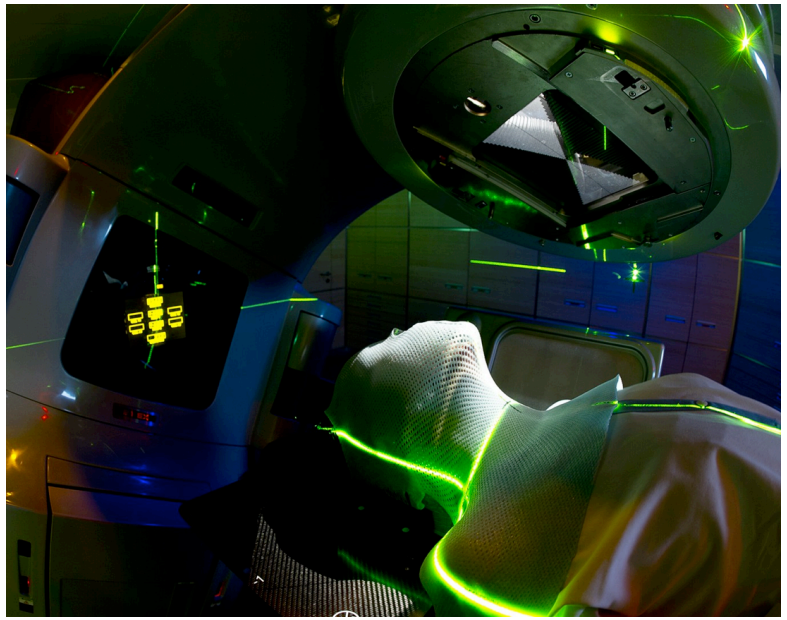
ENVISION

European Novel Imaging Systems for Ion Therapy

Accurate positioning is a crucial challenge
for targeting moving organs during particle treatment

- 4-year EU funded project: Budget 6M euros
- launched in February 2010
- 16 leading European research centres and industrial partners, coordinated by CERN
- R&D in real-time medical imaging for more precise and effective hadron therapy
  - 2 demonstrators for real time imaging have been constructed and are being tested
  - > 40 scientific publications and 80 conference talks/posters

Selected by EC CORDIS science editors



ENTERVISION

- Marie Curie ITN for young scientists
  - Uses ENVISION as training platform
- 15 researchers recruited
  - 12 Early Stage, 3 Experienced
  - 9 nationalities
  - From medical physics, engineering, nuclear physics, HEP, biological physics

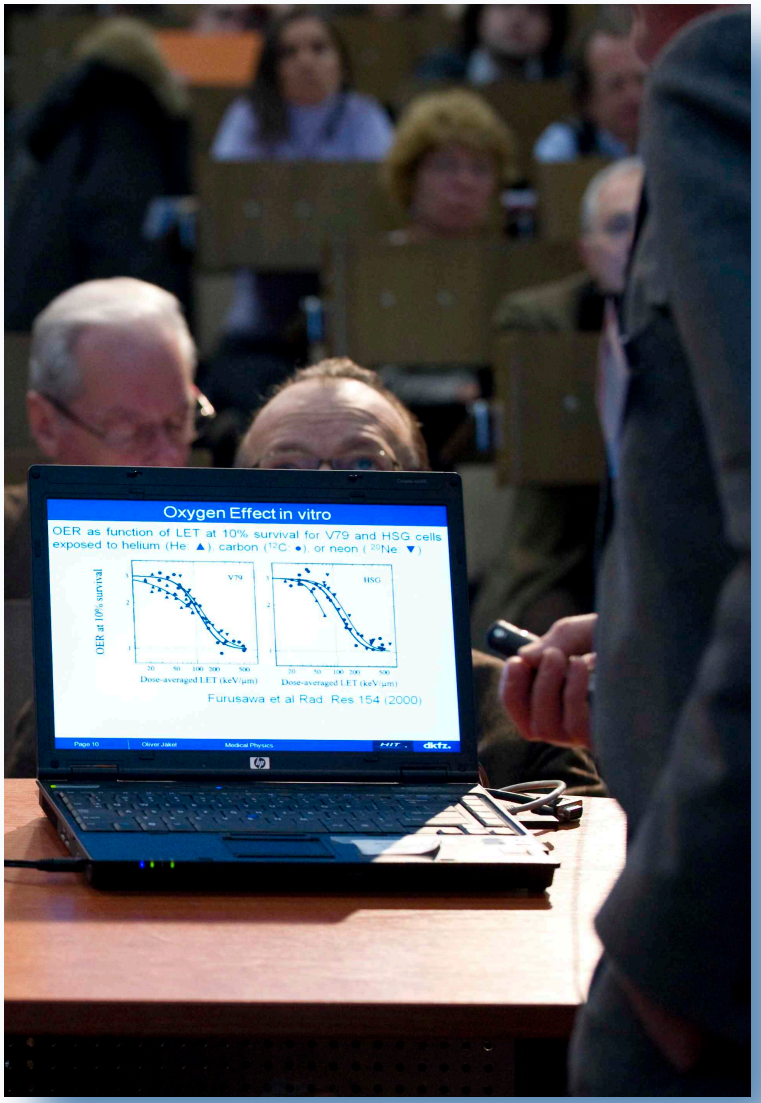
4 research work packages

- Hardware and software solutions for signal handling, data acquisition and processing for image based in-vivo dosimetry
- Modelling of in-beam PET and SPECT imaging devices
- Nuclear fragmentation studies
- Integration of treatment related imaging and dosimetry data

Preparing for the Future

Objective

- Review progress in physics for health
- Identify areas for development
- Explore synergies
  - physics and health
- Catalyse dialogue
  - doctors, physicists, medical physicists……

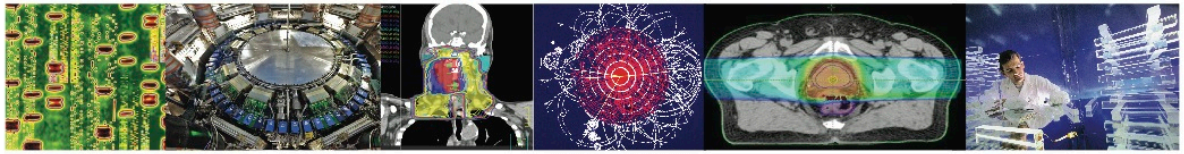


Result:

First workshop on Physics for Health @CERN in Feb 2010

ICTR-PHE 2012

Uniting physics, biology and medicine for better healthcare



International Conference on Translational Research in Radio-Oncology

&

Physics for Health in Europe

February 27 – March 2, 2012 at CICG, Geneva

2 days devoted to physics, 2 days to medicine [illegible] topics

Over 700 people registered, nearly 400 Abst[illegible]

Chairs: Jacques Bernier (Genolier) and [illegible]

Four physics subjects :

- Radiobiology in the[illegible]
- Detectors and [illegible]
- Radioisotopes in o[illegible] therapy
- Novel technologies

Next ICTR-PHE Conference
10-14 February 2014
Registration Open

http://ictr-phe12.web.cern.ch/ICTR-PHE14

Looking forward…

- **Bio-LEIR facility**: requested by community (>20 countries, >200 people)
- **PIMMS-2:** second generation facilities
- **Medicis** (using ISOLDE) for exotic isotopes for future R&D
- **Bio-informatics:** Grids, data sharing, patient referral…..
- **Imaging:** Detectors, multimodality, real-time ……

Thank you for your attention